

What is claimed is:

1. A method of making a low loss optical waveguiding structure disposed on a top surface of a silicon-on-insulator (SOI) wafer comprising a silicon substrate, a buried dielectric layer and a relatively thin silicon surface waveguiding layer disposed over the buried dielectric layer, the method comprising the steps of:

forming a relatively thin dielectric layer over at least a portion of the relatively thin silicon surface waveguiding layer;

forming a silicon waveguiding structure over at least a portion of the relatively thin dielectric layer, the combination of the contiguous portions of the relative thin silicon surface waveguiding layer, the relatively thin dielectric layer and the silicon waveguiding structure forming an optical waveguiding region, at least one of both the relatively thin silicon surface waveguiding layer and the silicon waveguiding structure defined as exhibiting at least one right-angled edge in the waveguiding region; and

rounding at least one right-angled edge in the optical waveguiding region to reduce optical loss in the optical waveguiding structure.

2. The method as defined in claim 1 wherein during the performance of the rounding step, the method comprises the further steps of:

forming a sacrificial silicon layer over the silicon waveguiding structure; and

processing the sacrificial silicon layer to form rounded edges along the borders of the optical waveguiding region.

3. The method as defined in claim 2 wherein in performing the processing step, the following step is performed:

etching the sacrificial silicon layer to form rounded sidewall fillets along the lateral borders of the optical waveguiding region.

4. The method as defined in claim 3 where an isotropic etching process is used.

5. The method as defined in claim 3 where an anisotropic etching process is used.

6. The method as defined in claim 3, where a combination of an anisotropic etching process and an isotropic etching process is used to form both top rounded edges and bottom rounded edges in the optical waveguiding region.

7. The method as defined in claim 3 wherein plasma etching is used to form the sacrificial silicon sidewall fillets.

8. The method as defined in claim 7 wherein the plasma etching species is selected from the group consisting of: hydrogen, fluorine, chlorine, bromine and iodine.

9. The method as defined in claim 3 wherein reactive ion etching is used to form the sacrificial silicon sidewall fillets.

10. The method as defined in claim 2 wherein prior to forming the sacrificial silicon layer, an etch stop layer is formed to cover the silicon waveguiding structure and exposed surfaces of the relatively thin dielectric layer.

11. The method as defined in claim 10 wherein in performing the processing step, the following step is performed:

etching the sacrificial silicon layer to form rounded sidewall fillets along the lateral borders of the optical waveguiding region.

12. The method as defined in claim 11 where an isotropic etching process is used.

13. The method as defined in claim 11 where an anisotropic etching process is used.

14. The method as defined in claim 11, where a combination of an anisotropic etching process and an isotropic etching process is used to form both top rounded edges and bottom rounded edges in the optical waveguiding region.

15. The method as defined in claim 11 wherein plasma etching is used to form the sacrificial silicon sidewall fillets.

16. The method as defined in claim 15 wherein the plasma etching species is selected from the group consisting of: hydrogen, fluorine, chlorine, bromine and iodine.

17. The method as defined in claim 11 wherein reactive ion etching is used to form the sacrificial silicon sidewall fillets.

18. The method as defined in claim 11 wherein the method comprises the further steps of:

masking selected waveguiding areas where corner rounding is desired; and
etching the exposed waveguiding areas to remove the rounded sidewall fillets.

19. The method as defined in claim 18 wherein plasma etching is used to remove the exposed, rounded sidewall fillets.

20. The method as defined in claim 2 wherein in performing the processing step, the following step is performed:

thermally oxidizing the sacrificial silicon layer to form silicon dioxide, thus forming rounded edges along the lateral extent of the optical waveguiding region.

21. The method as defined in claim 1 wherein the method further comprises the step of hydrogen annealing the optical waveguiding structure to smooth surfaces of the silicon waveguiding structure.

22. The method as defined in claim 1 wherein the rounding step comprises the step of depositing the silicon waveguiding structure over a non-planar surface to create rounded edges at various locations where the surface changes height.

23. The method as defined in claim 1, wherein the step of forming a silicon waveguiding structure comprises depositing a blanket layer of silicon, and the rounding step comprises the steps of:

depositing an oxidation-resistant layer over the blanket deposited silicon layer;
patterning the oxidation-resistant layer to define and protect the location of an optical waveguiding region; and

thermally oxidizing the exposed blanket-deposited silicon layer to convert said blanket-deposited silicon layer into silicon dioxide, the thermal oxidation resulting in lifting the oxidation-resistant layer and forming a bird's beak rounding of the underlying blanket-deposited silicon in the pre-defined optical waveguiding region.

24. The method as defined in claim 23, the method further comprising the step of removing the remaining oxidation-resistant layer.

25. The method as defined in claim 23, the method further comprising the step of removing the converted silicon dioxide.

26. The method as defined in claim 23 where silicon nitride is used as the oxidation-resistant material.

27. The method as defined in claim 1 wherein the form of silicon used for either one or both of the silicon waveguiding structures and the sacrificial silicon layer is one or more forms of silicon chosen from the group consisting of: polysilicon, amorphous silicon, strained silicon, substantially single crystal silicon, and single crystal silicon.

28. The method as defined in claim 27 wherein the polysilicon may comprise one or more forms of polysilicon chosen from the group consisting of grain-size-enhanced polysilicon, grain-boundary-passivate polysilicon and grain-aligned polysilicon.

29. The method as defined in claim 1 wherein the silicon waveguiding structure comprises a single layer of silicon material.

30. The method as defined in claim 1 wherein the silicon waveguiding structure comprises a plurality of layers of silicon material.

31. The method as defined in claim 30 where each layer in the plurality of layers comprises the same form of silicon.

32. The method as defined in claim 30 wherein at least two layers in the plurality of layers comprise different forms of silicon.

33. The method as defined in claim 1 wherein the rounding step is performed to round at least one right-angled edge in the relatively thin silicon surface waveguiding layer.

34. The method as defined in claim 33 wherein the method further comprises the steps of:

forming an oxidation-resistant material over an exposed top surface of the relatively thin silicon surface waveguiding layer;

performing a thermal oxidation of said relatively thin silicon surface waveguiding layer to convert a surface portion of said relatively thin silicon surface waveguiding layer into silicon dioxide, the conversion process rounding said at least one right-angled edge in the waveguiding region; and

removing the silicon dioxide and the oxidation-resistant material.

35. The method as defined in claim 17 wherein the oxidation-resistant material comprises silicon nitride.

36. A low loss optical waveguiding structure disposed on a top surface of a silicon-on-insulator (SOI) wafer comprising a silicon substrate, a buried dielectric layer and a relatively thin silicon surface waveguiding layer disposed over the buried dielectric layer, the low loss optical waveguiding structure comprising

a relatively thin dielectric layer disposed over at least a portion of the relatively thin silicon surface waveguiding layer;

a silicon waveguiding structure disposed over at least a portion of the relatively thin dielectric layer, the combination of the contiguous portions of the relative thin silicon

surface waveguiding layer, the relatively thin dielectric layer and the silicon waveguiding structure forming an optical waveguiding region, at least one of both the relatively thin silicon surface waveguiding layer and the silicon waveguiding structure defined as exhibiting at least one rounded edge in the waveguiding region to reduce optical loss in the optical waveguiding structure.

37. A low loss optical waveguiding structure as defined in claim 36 wherein the relatively thin silicon surface waveguiding layer includes at least one rounded edge in the waveguiding region.

38. A low loss optical waveguiding structure as defined in claim 36 wherein the silicon waveguiding structure comprises at least one rounded edge in the waveguiding region.

39. A low loss optical waveguiding structure as defined in claim 36 wherein the at least one rounded edge comprises a sidewall silicon fillet disposed contiguous with the silicon waveguiding structure.

40. A low loss optical waveguiding structure as defined in claim 36 wherein the structure further comprises a relatively thin etch stop layer disposed over the relatively thin silicon surface waveguiding layer.

41. A low loss optical waveguiding structure as defined in claim 36 wherein the waveguiding structure is a passive device.

42. A low loss optical waveguiding structure as defined in claim 36 wherein the waveguiding structure is an active device, with the relatively thin silicon surface waveguiding layer exhibiting a first conductivity type and the silicon waveguiding structure exhibiting a second conductivity type.